

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Izbrana poglavja iz fizike mehke snovi
Course title:	Selected topics on soft matter physics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		1. ali .2	1. ali 2.
PHYSICS, 3 rd cycle		1. or 2.	1. or 2.

Vrsta predmeta / Course type

Izbirni za modula Biofizika in Fizika

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
10	5				165	6

Nosilec predmeta / Lecturer:

Nataša Vaupotič

Jeziki /

Languages:

Predavanja /

Lectures:

Vaje / Tutorial:

slovenski/Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Ni pogojev. Priporočeno je predznanje iz klasične in moderne fizike in fizike trdne snovi.

Prerequisites:

None. Preknowledge of classical and modern physics and solid state physics is recommended.

Vsebina:

Obravnavani bodo aktualni primeri s področja fizike mehke snovi.

Predavanja bodo pokrivala področja raziskav osnovnih principov kot tudi področje aplikacij.

Izbrane vsebine se bodo prilagajale področju znanstvenoraziskovalnega dela doktorskega študenta. Primeri vsebin: kontinuumski in diskretni modeli (različne vrste tekočih kristalov, koloidi, polimeri...), naravna, inducirana in strukturna kiralnost, optične, toplotne, električne, magnetne in mehanske

Content (Syllabus outline):

Recent advances in soft matter physics will be studied.

The lectures will cover research of basic principles and also of applications.

Topics will be chosen in accordance with the candidate's research work. Examples of topics: continuum and discrete models (for different phases of liquid crystals, colloids, polymers...), natural, induced and structural chirality; optical, thermal, electric, magnetic and mechanical properties of soft matter materials, theoretical

lastnosti mehke snovi, teoretična obravnava eksperimentalnih meritev (dielektrične meritve, optične meritve, elastična in resonančna rentgenska spektroskopija...).

studies of experimental measurements (dielectric measurements, optical measurements, elastic and resonant x-ray spectroscopy...).

Temeljni literatura in viri / Readings:

- 1) M. Kleman, O.D. Lavrentovich, *Soft Matter Physics* (Springer-Verlag, New York, 2003).
- 2) P. M. Chaikin, T. C. Lubensky, *Principles of Condensed Matter Physics* (Cambridge University Press, Cambridge, 1995).
- 3) J. Selinger, *Introduction to the Theory of Soft Matter: From Ideal Gases to Liquid Crystals* (Springer, Heidelberg, 2016).
- 4) R. A. L. Jones, *Soft Condensed Matter* (Oxford University Press, Oxford, 2001).
- 5) J. Als-Nielsen in D. McMorrow, *Elements of Modern X-Ray Physics* (Wiley, New York, 2001).
- 6) M. Fox, *Optical Properties of Solids* (Oxford University Press, Oxford, 2010).
- 7) Znanstvenoraziskovalni članki s področja obravnavanih tem/ Scientific research papers from chosen topics.

Cilji in kompetence:

Namen predmeta je študente usposobiti za raziskovalno delo na izbranem področju fizike mehke snovi.

Objectives and competences:

The objective of this course is to teach students how to carry out research work on a selected field within soft matter physics.

Predvideni študijski rezultati:

Znanje in razumevanje:

Po zaključku tega predmeta bo študent zmožen:

- analizirati, vrednotiti in primerjati najnovejše raziskave na izbranem področju fizike mehke snovi;
- uporabiti napredno fizikalno znanje in matematične metode na danem področju za analizo in vrednotenje fizikalnih pojavov v odvisnosti od relevantnih fizikalnih parametrov in spremenljivk;
- prepoznati analogije med različnimi pojavi in jih uporabiti za obravnavo novih pojavov.

Prenosljive/ključne spretnosti in drugi atributi:

Intended learning outcomes:

Knowledge and understanding:

On completion of this course the student will be able to:

- analyse, evaluate and compare the latest research on a chosen field of soft matter physics;
- use advanced physical knowledge and mathematical methods from a specific field for an analysis and evaluation of physical effects as a function of physical parameters and variables;
- recognise analogies among different effects and apply them to describe novel physical effects.

Transferable/Key Skills and other attributes:

<ul style="list-style-type: none"> - <i>Spretnosti komuniciranja</i>: ustno in pisno izražanje pri predstavitvi izbrane teme. - <i>Uporaba informacijske tehnologije</i>: uporaba programskih orodij za modeliranje in obdelavo podatkov. - <i>Reševanje problemov</i>: prepoznavanje univerzalnosti, analogij in celosten pristop k reševanju problemov. 	<ul style="list-style-type: none"> - <i>Communication skills</i>: manner of expression at written and oral presentation of a chosen topic. - <i>Use of information technology</i>: use of software tools for modelling and data manipulation. - <i>Problem solving</i>: ability to recognize universalities, analogies, and global approach to solving problems.
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Metode poučevanja in učenja:

Predavanja, seminarji, konzultacije, razlaga, razgovor, delo s tekstom, metoda pisnih in grafičnih del, problemsko učenje, študija primera, raziskovalno učenje, uporaba programskih orodij.

Learning and teaching methods:

Lectures, seminars, tutorials, explanation, discussion, work with text, work with graphic elements, case study, problem based learning, inquiry based learning, use of software tools.

	Delež (v %) / Weight (in %)	Assessment:
Načini ocenjevanja:		Type (examination, oral, coursework, project):
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		
4 seminarji	100%	4 seminars
Delež posameznega seminarja je 25%, vsak mora biti ocenjen pozitivno.		Each seminar contributes 25% and each has to be marked positive.

Reference nosilca / Lecturer's references:

1. SALAMONCZYK, Miroslaw, VAUPOTIČ*, Nataša, POCIECHA, Damian, WALKER, Rebecca, STOREY, John M. D., IMRIE, Corrie T., WANG, Cheng, ZHU, Chenhui, GÓRECKA, Ewa. Multi-level chirality in liquid crystals formed by achiral molecules. *Nature communications*, ISSN 2041-1723, 2019, vol. 8, str. 1922-1-1922-8, doi: [10.1038/s41467-019-09862-y](https://doi.org/10.1038/s41467-019-09862-y). [COBISS.SI-ID [32322855](https://www.cobiss.si/id/32322855)].
2. VAUPOTIČ, Nataša, ALI, Muhammad, MAJEWSKI, P., GÓRECKA, Ewa, POCIECHA, Damian. Polarization gratings spontaneously formed from a helical twist-bend nematic phase. *ChemPhysChem : a European journal of chemical physics and physical chemistry*, ISSN 1439-4235. [Print ed.], [in press] 2018, 15 str., doi: [10.1002/cphc.201800360](https://doi.org/10.1002/cphc.201800360). [COBISS.SI-ID [31667751](https://www.cobiss.si/id/31667751)].
3. SALAMONCZYK, Miroslaw, VAUPOTIČ*, Nataša, POCIECHA, Damian, WANG, Cheng, ZHU, Chenhui, GÓRECKA, Ewa. Structure of nanoscale-pitch helical phases : blue phase and twist-bend nematic phase resolved by resonant soft X-ray scattering. *Soft matter*, ISSN 1744-683X, 2017, vol. 13, no. 38, str. 6694-6699, doi: [10.1039/c7sm00967d](https://doi.org/10.1039/c7sm00967d). [COBISS.SI-ID [30804519](https://www.cobiss.si/id/30804519)].
4. GÓRECKA, Ewa, VAUPOTIČ*, Nataša, ZEP, Anna, POCIECHA, Damian. From sponges to nanotubes : a change of nanocrystal morphology for acute-angle bent-core molecules. *Angewandte Chemie*, ISSN 1521-3773. [Online ed.], 2016, vol. 55, no. 40, str. 12238-12242, doi: [10.1002/anie.201604915](https://doi.org/10.1002/anie.201604915). [COBISS.SI-ID [29763367](https://www.cobiss.si/id/29763367)].
5. VAUPOTIČ, Nataša, CURK, Samo, OSIPOV, Mikhail, ČEPIČ, Mojca, TAKEZOE, Hideo, GÓRECKA, Ewa. Short-range smectic fluctuations and the flexoelectric model of modulated nematic liquid crystal. *Physical*

review. *E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2016, vol. 93, no. 2, str. 022704-1-022704-5, doi: [10.1103/PhysRevE.93.022704](https://doi.org/10.1103/PhysRevE.93.022704). [COBISS.SI-ID [29301799](#)].

6. MATRASZEK, Joanna, TOPNANI, Neha, VAUPOTIČ*, Nataša, TAKEZOE, Hideo, MIECZKOWSKI, Jozef, POČIECHA, Damian, GÓRECKA, Ewa. Monolayer filaments versus multilayer stacking of bent-core molecules. *Angewandte Chemie*, ISSN 1433-7851. [Print ed.], 2016, vol. 55, iss. 10, str. 3468-3472, doi: [10.1002/anie.201510123](https://doi.org/10.1002/anie.201510123). [COBISS.SI-ID [29302055](#)].

7. GÓRECKA, Ewa, VAUPOTIČ*, Nataša, ZEP, Anna, POČIECHA, Damian. From sponges to nanotubes : a change of nanocrystal morphology for acute-angle bent-core molecules. *Angewandte Chemie*, ISSN 1521-3773. [Online ed.], 2016, vol. 55, no. 40, str. 12238-12242, doi: [10.1002/anie.201604915](https://doi.org/10.1002/anie.201604915). [COBISS.SI-ID [29763367](#)],

8. VAUPOTIČ, Nataša, CURK, Samo, OSIPOV, Mikhail, ČEPIČ, Mojca, TAKEZOE, Hideo, GÓRECKA, Ewa. Short-range smectic fluctuations and the flexoelectric model of modulated nematic liquid crystal. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2016, vol. 93, no. 2, str. 022704-1-022704-5, doi: [10.1103/PhysRevE.93.022704](https://doi.org/10.1103/PhysRevE.93.022704). [COBISS.SI-ID [29301799](#)].

9. GÓRECKA, Ewa, VAUPOTIČ*, Nataša, ZEP, Anna, POČIECHA, Damian, YOSHIOKA, Jun, YAMAMOTO, Jun, TAKEZOE, Hideo. A twist-bend nematic (N_{sub}(TB)) phase of chiral materials : Ewa Gorecka ... [et al.]. *Angewandte Chemie*, ISSN 1433-7851. [Print ed.], 2015, vol. 54, no. 35, str. 10155-10159, doi: [10.1002/anie.201502440](https://doi.org/10.1002/anie.201502440). [COBISS.SI-ID [28844839](#)].